

# SYSTEMATICS OF *CIRSIMUM* (COMPOSITAE) IN WYOMING

ROBERT C. GARDNER

Department of Botany, The Ohio State University, Columbus 43210  
(Publication no. 845 from the Department of Botany,  
Ohio State University)

Wyoming thistles (*Cirsium* spp.) are found in a wide range of habitats, from mesic to arid and lowland (1110 m) to alpine (3450 m). Many are particularly suited to invasion of disturbed sites and are common roadside weeds throughout much of the state.

Taxonomists have differed as to the number of native species of *Cirsium* in Wyoming, from as few as eight to as many as 21 (Rydberg, 1906, 1917; Coulter and Nelson, 1909; Petrak, 1917). More recently, Frankton and Moore (1961) and Moore and Frankton (1963, 1964, 1965, 1967, and 1969), using cytological as well as morphological data to delimit taxa, suggest that 16 *Cirsium* species probably occur in the state.

In attempting to understand the genus, I have employed morphological studies, field observations, chromosome numbers, and leaf flavonoid chemistry. Although this treatment is limited to the species of *Cirsium* that occur in Wyoming, field work was carried out in adjacent states. In addition, specimens of foliose thistles from Canada and the western United States, all annotated by R. J. Moore, were borrowed from the Canadian Department of Agriculture, Ottawa, Canada (DAO). All specimens cited in this paper are deposited in the Rocky Mountain Herbarium (RM) unless otherwise indicated.

## MATERIALS AND METHODS

Standard techniques were used in determining chromosome numbers (Gardner, 1972). For seed germination the procedures of Ownbey and Hsi (1963) were followed, and root tip staining was achieved by Snow's (1963) method. Voucher specimens for all counts are deposited in RM.

Paper chromatography was employed on a minimum of five collections from different populations, following the procedures of Crawford (1970). Thin layer chromatography was used to characterize flavonoid profiles of additional specimens. Certain species were characterized by high chlorophyll and lipid concentrations and relatively low flavonoid content, and it was necessary to pre-extract with ether in order to remove these excess compounds. After determining color reactions and  $R_f$  values on paper chromatograms, and ultraviolet spectroscopy of the purified compounds, the phenolics were identified by comparing their properties with published results (ApSimon et al., 1963; Doherty et al., 1963;

Harborne, 1967; Challice and Williams, 1968; Mabry et al., 1970; Wallace and Bohm, 1971; Giannasi, 1972; Mears and Mabry, 1972). When sufficient material was available, individual compounds were hydrolyzed. Both acidic and enzymic hydrolyses were attempted, using the procedures outlined by Harborne (1965).

#### CYTOLOGY

In this study, ten species of *Cirsium* were found to have  $2n = 34$  (Table 1), suggesting a base number of  $x = 17$ . Three taxa, i.e., *C. flodmanii*,  $2n = 22$ ; *C. undulatum*,  $2n = 26$ ; and *C. ochrocentrum*,  $2n = 30$  and  $32$ , have numbers that are considered reductions (cf. Frankton and Moore, 1961). Variation was found in single collections of *C. coloradense*,  $2n = 32$  (fig. 1) and *C. centaureae*,  $2n = 36$  (fig. 1). However, other collections of these species have the usual  $2n = 34$ . With these exceptions, my counts agree with published reports. Cytological data are included under the discussion of *Cirsium pulcherrimum* and *C. subniveum* because of their importance in differentiating the two taxa.

#### LEAF FLAVONOID STUDIES

Flavonoid studies were made on the leaves of 11 Wyoming species of *Cirsium*. Although the taxa studied produce similar leaf flavonoids, none has a profile identical to another (fig. 2). These chemical features have been extremely useful from a taxonomic standpoint, particularly with those species that are morphologically similar.

Of the 19 flavonoids identified (Table 2), ten are methylated flavone glycosides, i.e., acacetin, diosmetin, and chrysoeriol. In addition to B-

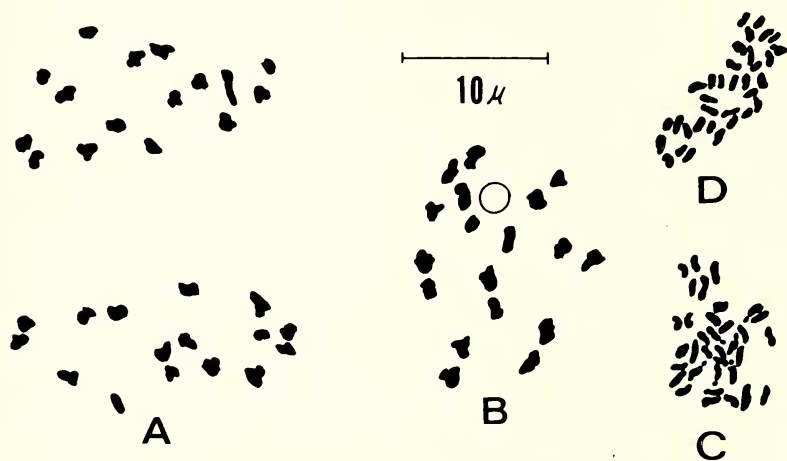


FIG. 1. Camera lucida drawings of *Cirsium* chromosomes. A. *C. coloradense*, first telophase ( $n = 16$ ); B. *C. centaureae*, diakinesis ( $n = 18$ ); C. *C. subniveum*, mitotic metaphase ( $2n = 34$ ); D. *C. pulcherrimum*, mitotic metaphase ( $2n = 34$ ).

TABLE 1. CHROMOSOME NUMBERS IN SOME SPECIES OF CIRSIUM. Collection numbers are those of the author and voucher specimens are in RM. Collections marked with an asterisk (\*) are illustrated in Figure 1.

*Cirsium canescens* Nutt.  $n = 17$ . Colorado: Larimer Co.: Albany County Road 34 to Colorado, 27 mi SW of Laramie, Wyoming, 159; Wyoming: Albany Co.: 2 mi SE of Laramie, 108, 109, 110; Hwy. 34,  $\frac{1}{2}$  mi E of Morton's Pass, 117; Laramie Co.: I-80, 7 mi W of Cheyenne, 156A; Hwy. 214, 1 mi S of I-80 Burns-Carpenter Exit, 168.

*Cirsium centaureae* (Rydb.) K. Schum.  $n = 17$ . Colorado: Larimer Co.: Hwy. 34, 6 mi E of Estes Park, 116; Wyoming: Albany Co.: NE of Laramie, 1 mi SE of quarry, 143.  $n = 18$ . Hwy. 130, 3 mi W of Centennial, 146\*.

*Cirsium coloradense* (Rydb.) Cockerell.  $n = 17$ . Colorado: Larimer Co.: Albany County Road 34 to Colorado, 29 mi SW of Laramie, Wyoming, 161; 32 mi SW of Laramie, Wyoming, 162B; Wyoming: Albany Co.: County Road, 3 mi N of Fox Park, 166.  $n = 16$ . Hwy. 287, 9 mi S of Laramie, 111\*; Carbon Co.: Road to Shirley Basin, 14 mi from intersection of Hwy. 487, 125.  $n = 17$ . Hwy. 130, 3 mi W of Ryan Park, 147A.

*Cirsium drummondii* Torrey & Gray,  $2n = 34$ . South Dakota: Custer Co.: Hwy. 87, 1 mi NE of west entrance to Custer State Park, 174.

*Cirsium flodmanii* (Rydb.) Arthur.  $n = 11$ . Colorado: Weld Co.: road between Hereford and Grover, 1 mi S of Hereford, 169; South Dakota: Custer Co.: all along road through Custer State Park, 173; Wyoming: Johnson Co.: Hwy. 16, 3 mi NE of Buffalo, 136; Hwy. 87, 23 mi. S of Buffalo, 186; Weston Co.: Old Boyd Townsite, E. of Four Corners Store, 176.

*Cirsium foliosum* (Hook.) DC.  $2n = 34$ . Wyoming: Sheridan Co.: Hwy. 14 alternate, 4 mi W of Burgess Jct., 191.

*Cirsium ochrocentrum* A. Gray.  $n = 16$ . Wyoming: Fremont Co.: Hwy. 26-287, 17 mi NW of Lander, 209; Laramie Co.: I-80, 10 mi E of Cheyenne, 167.  $n = 15$ . I-25, 15 mi S of Chugwater, 155; Platte Co.: Hwy. 126, 12 mi E of jct. with I-25, 121.  $n = 16$ . Hwy. 34,  $1\frac{1}{2}$  mi SW of Sybille Creek, 154.

*Cirsium pulcherrimum* (Rydb.) K. Schum.  $n = 17$ . Wyoming: Washakie Co.: Hwy. 16, 30 mi E of Tensleep, 131, 132; Sweetwater Co.: 5 mi S of Creston Jct., 153.  $2n = 34$ . Road to Bitter Creek, 6 mi S of I-80, 211\*.

*Cirsium scariosum* Nutt.  $n = 17$ . Wyoming: Yellowstone National Park: east entrance road, 18 mi W of entrance, 196.

*Cirsium subniveum* Rydb.  $2n = 34$ . Wyoming: Grand Teton National Park: Gros Ventre Campground, 199\*; Teton Co.: along roadside at jct. of Hoback and Snake Rivers, 200.

*Cirsium undulatum* (Nutt.) Spreng.  $n = 13$ . Colorado: Larimer Co.: Hwy. 287, 15 mi N of Fort Collins, 113; Wyoming: Albany Co.: Hwy. 34, 6 mi E of Morton's Pass, 118; Goshen Co.: Hwy. 85, 15 mi S of Torrington, 178; Washakie Co.: Hwy. 16, 25 mi E of Tensleep, 130.

#### Putative hybrids:

*Cirsium coloradense*  $\times$  *C. canescens*.  $n = 16$ . Colorado: Larimer Co.: Albany County Road 34 to Colorado, ca. 25 mi SW of Laramie, Wyoming, 158A.  $n = 17$ . 158C; Wyoming: Albany Co.: County Road 17, 1 mi NW of Horse Creek, 142; Carbon Co.: Hwy. 130, 3 mi W of Ryan Park, 147C.

*Cirsium tweedyi*  $\times$  *C. pulcherrimum*.  $2n = 35$  & 36. Wyoming: Sheridan Co.: Hwy. 14, 15 mi E of Burgess Jct., 189.

ring methylation, 6-methylated apigenin, acacetin, and chrysoeriol have been found. Although few reports of methylated compounds from the leaves of *Cirsium* exist in the literature (Harborne, 1967; Wallace and

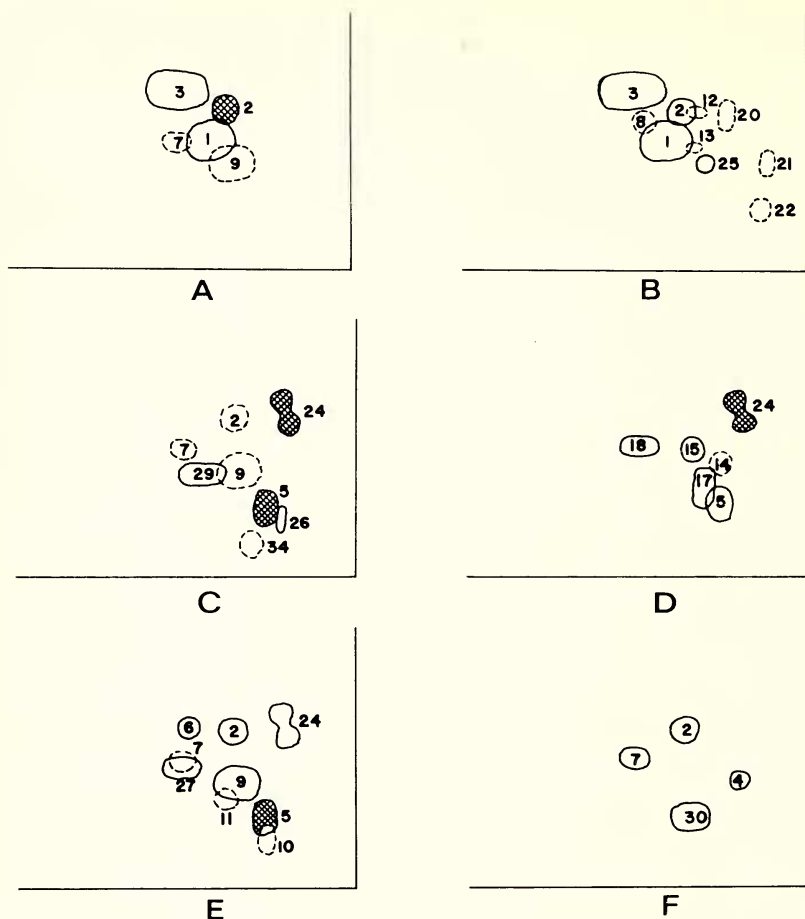


FIG. 2. Drawings of 2-dimensional paper chromatograms of *Cirsium* leaf extracts. Cross-hatching indicates compounds common to both taxa being considered. A. *C. coloradense*, solid line; *C. scariosum*, dashed line; B. *C. foliosum*, solid line; *C. drummondii*, dashed line; C. *C. flodmanii*, solid line; *C. undulatum*, dashed line; D. *C. canescens*, solid line; *C. ochrocentrum*, dashed line; E. *C. subniveum*, solid line; *C. pulcherrimum*, dashed line; F. *C. tweedyi*.

Bohm, 1971; McGowan and Wallace, 1972; Moriata et al., 1973), methylation is characteristic of the Wyoming species of the genus. Five 7-O-glycosides of the common flavones apigenin, luteolin, and vicenin, the 6-, 8-di-*C*-glycoside of apigenin, were also found. An additional eight unidentified compounds (Table 3) were considered to be of taxonomic value.

#### HYBRIDIZATION

There are numerous reports of *Cirsium* hybrids in the literature (Rydberg, 1917; Petrak, 1917; Cronquist, 1955; and Moore and Frank-



TABLE 2. IDENTIFIED LEAF FLAVONOIDS OF WYOMING *CIRSIIUM*. Spot designations correspond to those in Figure 2.

Spot-designation	Identity of Flavonoid
1	acacetin 7- <i>O</i> -rutinoside
2	quercetin 3- <i>O</i> -diglycoside
3	6-methoxy acacetin 7- <i>O</i> -rutinoside #
5	chrysoeriol 7- <i>O</i> -diglycoside
6	quercetin 3- <i>O</i> -diglycoside
7	quercetin 3- <i>O</i> -diglycoside
9	diosmetin 7- <i>O</i> -diglycoside *
10	luteolin 7- <i>O</i> -diglycoside
11	apigenin 7- <i>O</i> -di?glycoside
14	diosmetin 7- <i>O</i> -di?glycoside ? *
15	6-methoxy apigenin 7- <i>O</i> -diglucoside *
17	6-methoxy chrysoeriol 7- <i>O</i> -diglucoside*
18	apigenin 7- <i>O</i> -diglucoside
20	6-methoxy apigenin 8- <i>C</i> -glycoside ?
24	apigenin 6-, 8- <i>C</i> -diglycoside
27	acacetin 7- <i>O</i> -diglycoside
29	apigenin 7- <i>O</i> -diglycoside
30	luteolin 7- <i>O</i> -diglycoside ?
34	chrysoeriol 7- <i>O</i> -monoglycoside

# otherwise known only from Japanese and European members of the genus (Harborne, 1967).

\* first report of this compound from *Cirsium*.

TABLE 3. UNIDENTIFIED LEAF COMPOUNDS OF WYOMING *CIRSIIUM*. Spot designations correspond to those in Figure 2.

Spot designation	Color reactions on paper chromatograms*		R <sub>f</sub> Values	
	UV	UV+NH <sub>3</sub>	TBA	HOAc
4	D	D	.41	.51
8	D	G	.47	.59
12	D	G	.34	.62
13	D	D	.32	.49
21	D	G	.11	.42
22	D	D	.12	.24
25	D	D	.29	.42
26	D	Y	.21	.22

\* D = dark (no change), Y = yellow, G = green.

ton, 1967). Most of the hybrids listed involve either *C. coloradense* (Rydb.) Cockerell or *C. tioganum* (Congd.) Petrak as one of the parents.

During the course of my field work, I collected 21 plants that are apparent hybrids. Of these, I believe that 20 involve *Cirsium coloradense* as one parent. In some of the collections, leaf flavonoid profiles support the morphological data in the interpretation of these plants as hybrids, whereas in others, only the compounds of one putative parent were found and morphology is the only evidence for hybridization. The majority of putative hybrids that I found were in south central Wyoming

and adjacent Colorado. Generally, several hybrid plants occur in the same locality, suggesting that when isolating mechanisms break down, the plants hybridize freely.

The additive nature of flavonoid compounds has been shown to be quite useful as an additional character for documenting hybridization (Turner and Alston, 1959; Alston and Turner, 1962), but in the present study of hybrids, only five of the 21 putative hybrids display an additive chemical profile. All hybrids involving *C. coloradense* contain the compounds characteristic of that species, whereas only five of these plants produced any flavonoids normally found in the other putative parents i.e., *C. canescens* or *C. pulcherrimum*. It is possible that most of the specimens found are backcrosses to *C. coloradense* and that, as shown by Levin (1967), the profile of the non-recurrent parent can be lost in a first or subsequent generation backcross. It is also possible that the collections are advanced generation hybrids, and, if the loci governing the production of a given series of compounds are linked, these features could be lost through segregation (Belzer and Ownbey, 1971). Finally, the apparent lack of compounds typical of *C. canescens* or *C. pulcherrimum* may be quantitative rather than qualitative as a result of poor penetrance (Belzer and Ownbey, 1971). The acacetins produced by *C. coloradense* are much more concentrated than the flavonoids found in the profiles of *C. canescens* or *C. pulcherrimum*. It is significant that in the hybrids that do show a partially additive profile, the acacetins of *C. coloradense* appear to be of normal intensity, while the compounds of the other putative parents are somewhat reduced in quantity as compared to a "pure" *C. canescens* or *C. pulcherrimum* profile.

#### KEY TO THE SPECIES OF CIRSIMUM IN WYOMING

1. Involucre of largest mature heads (0.9–) 1.2–1.7 (–2.0) cm tall, 0.6–1.0 cm broad at the base; heads numerous, in loose corymbiform clusters; heads of two kinds, if pappus longer than corolla, anthers 1–2 mm long, if pappus shorter than corolla, anthers 4–5 mm long . . . . . 14. *C. arvense*
1. Involucre of largest mature heads more than 1.8 cm tall, 1 cm or more broad at base; heads solitary or in compact terminal clusters or axillary, not in corymbiform clusters; all anthers of similar length . . . . . 2.
2. Involucre of mature heads 3.5–5.0 cm tall; margins of inner rows of phyllaries dilated and lacerate near tip, usually with a glutinous dorsal ridge; yellow apical collar on achenes 0.4–0.8 mm broad . . . . . 3. *C. drummondii*
2. Plants not having the same combinations as above . . . . . 3.
3. Heads frequently in terminal clusters, occasionally axillary on upper half of stem; all heads exceeded by one to several cauline leaves; leaves not markedly reduced upwards; phyllaries without a glutinous dorsal ridge (occasionally a few glands on *C. tweedyi*) . . . . . 4.
3. Heads borne singly or in loose clusters, always one terminal on stem and branches, occasionally axillary on upper half of stem; heads never appreciably exceeded by cauline leaves; leaves markedly reduced upwards; phyllaries with or without a glutinous dorsal ridge . . . . . 7.
4. Pappus longer than the corolla by 1 mm or more; achenes 4 mm long and 2 mm or less broad . . . . . 4. *C. foliosum*

4. Pappus shorter than the corolla; achenes longer than 4 mm and 2 mm or more broad . . . . . 5.
  5. Leaf bases of most cauline leaves decurrent, wings 6–30 mm long; leaves glabrous above and below, rarely a thin tomentum below; involucre 1.0–1.5 cm broad at base . . . . . 11. *C. tweedyi*
  5. Leaf bases of all leaves clasping, not decurrent; leaves tomentose below; involucre 1.5–3.0 cm broad at base . . . . . 6.
  6. Sinus depth 75% or more of leaf width, when the middle portion of lower leaves is measured; pappus 22–24 mm long; corolla 22–29 mm long; style 26–32 mm long . . . . . 1. *C. coloradense*
  6. Sinus depth 74% or less of leaf width, when measured as above; pappus 14–21 mm long; corolla 16–24 mm long; style 19–26 mm long . . . . . 2. *C. scariosum*
  7. Phyllaries with coarsely lacerate margins, dilated in upper half; without a glutinous dorsal ridge . . . . . 12. *C. centaureae*
  7. Phyllaries with subentire or entire margins, tapering in upper half; usually with a glutinous dorsal ridge . . . . . 8.
  8. Upper leaf surfaces with minute, appressed spines, otherwise glabrous; outer phyllaries to 1 mm broad at base and reflexed near middle . . . . . 13. *C. vulgare*
  8. Upper leaf surfaces without appressed spines, either glabrous or tomentose; outer phyllaries 1–3 mm broad at base, not reflexed, although spines may be reflexed at base . . . . . 9.
  9. Leaves clasping stem, rarely decurrent, if so, wings less than 12 mm long . . . . . 10.
  9. Leaves decurrent, wings of middle cauline leaves at least 15 mm long. . . . . 11.
  10. Yellow apical collar on achenes 0.4–0.7 mm broad; rosette leaves, at least a few, and occasionally all cauline leaves entire, with marginal spines; upper leaf surface usually green . . . . . 6. *C. flodmanii*
  10. Yellow apical collar on achenes to 0.2 mm broad or lacking; rosette leaves and cauline leaves dissected, rarely subentire; upper leaf surface usually gray . . . . . 5. *C. undulatum*
  11. Decurrence of lowermost leaves greater than that of uppermost leaves; phyllaries conspicuously arachnoid pubescent, the hairs extending from margin of one phyllary to margin of adjacent phyllary . . . . . 10. *C. subniveum*
  11. Decurrence of lowermost leaves less than or nearly equal to that of uppermost leaves; phyllaries, if pubescent at all, only sparsely so along margins, rarely extending from phyllary to phyllary . . . . . 12.
  12. Lower leaves with at least some lobes 3.5–5.5 times longer than broad; involucre essentially square, phyllary spines 4 mm or less long, rarely to 5 mm long . . . . . 8. *C. canescens*
  12. Lower leaves without any lobes as much as 3 times longer than broad (rarely longer in *C. pulcherrimum*, but then upper leaf surface is bright green); involucre taller than broad; phyllary spines 4 mm or more long . . . . . 13.
  13. Involucre of mature heads 1.8–2.7 cm tall; upper leaf surface usually glabrous, rarely lightly tomentose . . . . . 9. *C. pulcherrimum*
  13. Involucre of mature heads 3.0–3.5 cm tall; upper leaf surface lightly tomentose to densely so . . . . . 7. *C. ochrocentrum*
1. *CIRSIUM COLORADENSE* (Rydb.) Cockerell ex Daniels, Univ. Missouri Studies, Sci. Ser. 2(2):402. (Oct) 1911.—*Carduus coloradense* Rydb., Bull. Torrey Bot. Club 32:132. 1905. TYPE: Colorado: Pagosa Springs, 1899, *C. F. Baker* 644. (Holotype: NY, not seen; Isotype: POM, not seen).

Plants acaulescent or with stems 3–6 (–8) dm tall; stems simple, rarely the upper portions with slender branches to 1 dm long; heads subtended by one to several leaves (lower leaves 18–30 cm long, 3–5 cm wide, sinus depth 75–90% of leaf width, subtending leaves 5–14 cm long, 1–3 cm wide, subentire to 100% divided), leaf bases clasping, marginal spines 5–15 mm long, generally longest on subtending leaves; heads axillary, scattered, sessile or on short peduncles (to 3 cm long), involucre 2–3 cm tall, 1.5–3.0 cm broad, about as broad as tall, with (5–) 7–10 (–12) rows of phyllaries, non-glandular, sometimes with dark midline; pappus (17–) 22–24 mm long; corolla white to pink, 22–29 mm long, the lobes 4–6 (–7) mm long; anthers 8–10 mm long; style 26–32 mm long, the branches 4–6 mm long; achenes 5–6 mm long, 2–3 mm wide, with or without a narrow yellow apical collar; flowers in mid-July and mature achenes are produced throughout August.

**DISTRIBUTION:** S Wyoming to Arizona and New Mexico. In Wyoming (fig. 3), it is often a weed of roadsides, pastures, or fields, usually in depressions or along drainages, suggesting a preference for moist sites; 1320–2450 m.

**REPRESENTATIVE SPECIMENS:** Wyoming: Albany Co.: Laramie, near High School, 3 Aug 1961, *Porter & Porter 8819*; Cummins, E side of

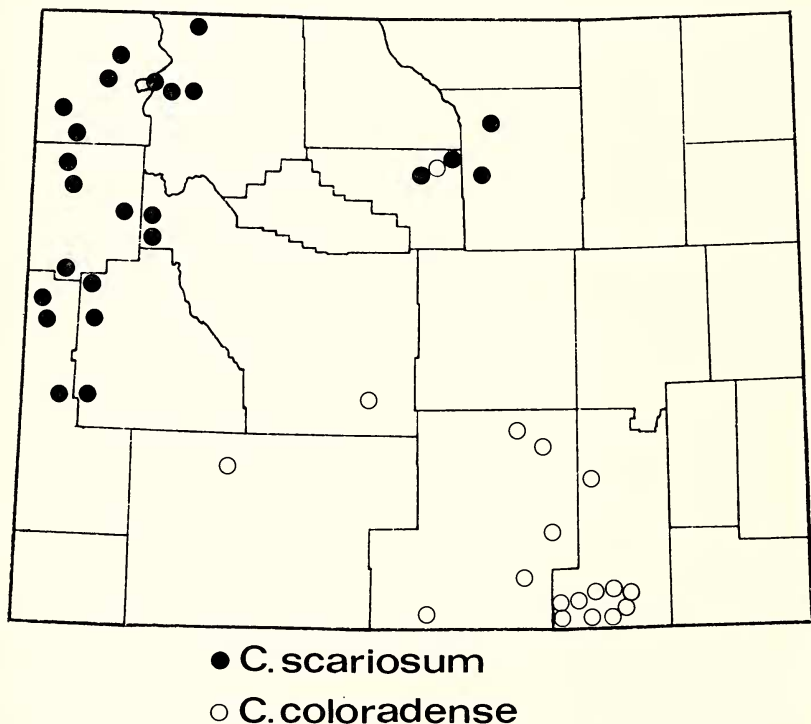


FIG. 3. Documented Wyoming distribution of *C. scariosum* and *C. coloradense*.

bridge, 6 Aug 1971, *Gardner 180A* (stemmed), *180B* (acaulescent). Carbon Co.: 14 mi N of Hwy. 487, road to Shirley Basin, 6 Jul 1971, *Gardner 125*; Hwy. 70, 30 mi E of Baggs, near Savory Stock Drive, 22 Jul 1971, *Gardner 151A* (5 dm tall), *151B* (2.2 dm tall). Fremont Co.: Hwy. 287-789, 10 mi W of Jeffrey City, 12 Aug 1971, *Gardner 210*. Sweetwater Co.: road to Boar's Tusk, 17 Aug 1971, *Gardner 212*. Washakie Co.: Hwy. 16, 1 mi E of Tensleep, 7 Jul 1971, *Gardner 129*.

In Wyoming, *Cirsium coloradense* often is confused with the closely related *C. scariosum* of the northwestern part of the state. A third closely related species, *C. tioganum* (Congd.) Petrak, has also been reported from the area. According to Moore and Frankton (1967), the latter taxon is characterized by being acaulescent (rarely stemmed), with oblanceolate leaves tapering basally to little more than a broad midvein. The author has not found any *Cirsium*, in the field nor in herbaria, with consistently oblanceolate leaves. Basal tapering of leaves is characteristic of most collections of all foliose thistles. I do not recognize these characteristics as sufficient to delimit the species and therefore, exclude *Cirsium tioganum* from the flora of Wyoming. A few specimens from Nevada and California fit the descriptions of the taxon more closely, but additional study is needed to determine if *C. tioganum* is in fact a "good" species.

All Wyoming acaulescent *Cirsium* that I have seen are *C. coloradense*. Two short stemmed plants (both about 5 cm tall) fall within the range of *C. scariosum*. These two species are most easily separated on corolla length and sinus depth/leaf width (fig. 4). It should be noted that plants with stems 1 dm or less tall are in both morphological ranges.

2. *CIRSIUM SCARIOSUM* Nutt., Trans. Amer. Philos. Soc. 7:420. 1841. TYPE: Idaho: Bingham Co.: Fort Hall, "Prairies of the Rocky Mts.", 1834, *Nuttall s.n.* (Holotype: BM, not seen).—*Cnicus scariosus* (Nutt.) A. Gray, Syn. Flora North Amer. 1:402. 1897.—*Carduus scariosus* (Nutt.) Heller, Cat. North Amer. Plants 7:134. 1898.

*Carduus kelseyi* Rydb., Mem. New York Bot. Gard. 1:449. 1900. TYPE: Montana: Helena, 21 Jul 1892, *Kelsey s.n.* (Holotype: OC, not seen).—*Cirsium kelseyi* (Rydb.) Petrak, Beih. Bot. Centralbl. 35(2):548. 1917.

*Carduus butleri* Rydb., Bull. Torrey Bot. Club 37:542. 1910. TYPE: Montana: Big Fork, 28 Jul 1908, *B. T. Butler 674*. (Holotype: NY, not seen).—*Cirsium butleri* (Rydb.) Petrak, Beih. Bot. Centralbl. 35(2):539. 1917.

*Carduus magnificus* A. Nelson, Bot. Gaz. (Crawfordsville) 53:228. 1912. TYPE: Idaho: Canyon Co.: Falk's Store, 22 Jun 1910, *J. F. Macbride 271*. (Holotype: RM!; Isotypes: F, not seen, RM!).—*Cirsium magnificum* (A. Nelson) Petrak, Beih. Bot. Centralbl. 35(2):551. 1917.



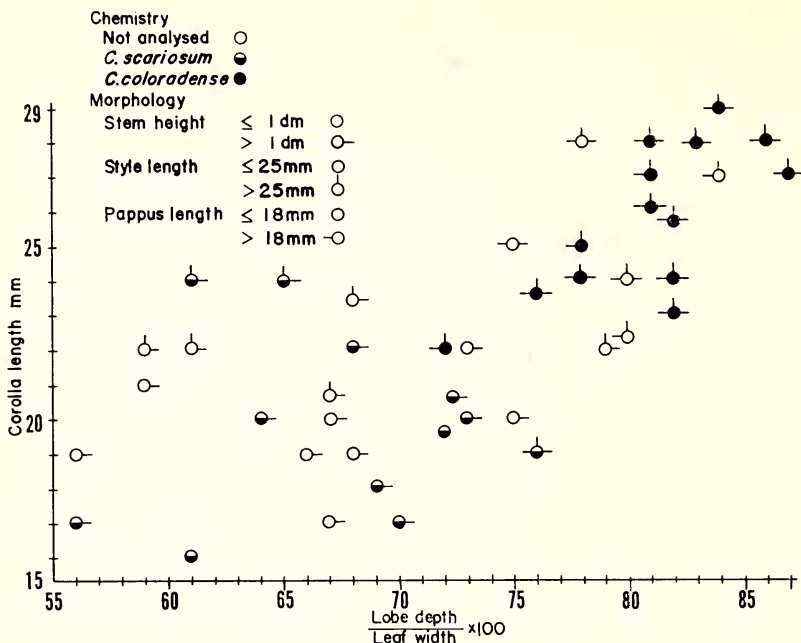


FIG. 4. Scatter diagram of morphological and chemical characteristics of *Cirsium coloradense* and *C. scariosum*.

Plants (0.5–) 4.0–6.0 (–7.0) dm tall, stems simple; heads subtended by one to several leaves [lower leaves (11–) 23–30 (–35) cm long, 2–3 cm wide, sinus depth 56–73% of leaf width, subtending leaves 11–20 cm long, 1–2 cm wide, subtire to shallowly divided], leaf bases clasping, marginal spines 4–10 mm long, generally longest on subtending leaves; heads axillary, sessile or on short peduncles (to 4 cm long), involucre 2.0–2.7 cm tall, 1.5–2.5 cm broad, about as broad as tall, with 5–8 rows of phyllaries, nonglandular; pappus 14–21 mm long; corolla white to purple, 16–24 mm long, the lobes 2–4 mm long; anthers 4–9 mm long; style 19–26 mm long, the branches 2–4 mm long; achenes 5–6 mm long, 2 mm wide, with or without a narrow yellow apical collar; flowers in early July and produces fruits by early August.

**DISTRIBUTION:** western one-fourth of Wyoming to Washington and Oregon and through the western half of Montana to Canada. In Wyoming (fig. 3), it is found in disturbed, moist sites, along roads and in pastures and fields; 2050–2900 m.

**REPRESENTATIVE SPECIMENS:** Wyoming: Fremont Co.: West side of Union Pass, 14 Aug 1894, *A. Nelson* 881; Hwy. 26–287, 4 mi E of Togwotee Pass summit, 12 Aug 1971, *Gardner* 207. Grand Teton National Park: 10 Aug 1971, *Gardner* 197A (6 dm tall), 197B (0.5 dm



tall). Johnson Co.: Headwaters of Clear Creek and Crazy Woman River, 20 Jul–15 Aug 1900, *Tweedy 3051*; Hwy. 16, 13.5 mi W of Buffalo, 15 Aug 1961, *Ownbey & Ownbey 3030*. Lincoln Co.: Moose Flats, along Gray's River, 4 Aug 1949, *C. L. Porter 5197*; Forest Route 138, 12 mi SE of jct. with Hwy. 189 (Alpine Jct.), 10 Aug 1971, *Gardner 201*. Park Co.: Clay Butte, near Beartooth Butte, 18 Aug 1951, *C. L. Porter 5924*; Hwy. 14–16–20, 7 mi E of Yellowstone National Park entrance, 10 Aug 1971, *Gardner 193*. Sublette Co.: 20 mi W of Big Piney, 11 Jul 1922, *Payson & Payson 2663*; Hwy. 189, 6.1 mi NW of Bondurant, 29 Jun 1962, *Gillett & Taylor 11612* (DAO). Teton Co.: Hoback Canyon, 11 Aug 1950, *Reed & Reed 3035*; Hwy. 26–287, 6 mi W of Togwotee Pass summit, 12 Aug 1971, *Gardner 206*. Washakie Co.: Head of Tensleep Canyon, 27 Jun 1960, *Porter & Porter 8231*; Hwy. 16, 35 mi E of Tensleep, 7 Jul 1971, *Gardner 133*. Yellowstone National Park: Snake River, 13 Aug 1899, *A. & E. Nelson 6443*; 18 mi W of east entrance, 10 Aug 1971, *Gardner 196*.

3. *CIRSIIUM DRUMMONDII* Torrey & Gray, *Flora North Amer.* 2(3):459. 1843. TYPE: Canada: "Fort Franklin on the Mackenzie River", *Richardson s.n.* (Neotype: Moore & Frankton, 1963: K, not seen). —*Cardus drummondii* (Torrey & Gray) Coville, *Contr. U. S. Natl. Herb.* 4:142. 1893.

*Cirsium coccinaeum* Osterhout, *Torreyana* 34:45. 1934. TYPE: South Dakota: Black Hills, near Hill City, 12 Jul 1932, *G. E. Osterhout 7826*. Holotype: RM!).

Plants (1.5–) 4.0–6.0 (–7.0) dm tall, stem simple; heads seldomly subtended by one to several leaves (lower leaves 15–23 cm long, 3–4 cm wide, sinus depth variable, leaves subentire or lobed to 80% of leaf width, subtending leaves 8–13 cm long, 0.5–2.0 cm wide, generally more divided than lower leaves, rarely subentire), leaf bases clasping, marginal spine length proportional to per cent leaf division (2–4 mm long on subentire leaves, 5–10 mm long on 50–80% divided leaves), generally longest on subtending leaves; heads terminal, solitary or 2 or 3 clustered near stem apex, involucre 3.5–5.0 cm tall, 2–4 cm broad, about half as broad as tall, with 6–8 rows of phyllaries, usually glandular (this most obvious on second and third rows), glabrous or pubescent along margins; pappus 30–40 mm long; corolla purple, 39–43 mm long, the lobes 6–7 mm long; anthers 7–9 mm long; style 42–50 mm long, the branches 6–7 mm long; achenes 5 mm long and 2 mm wide with a broad (0.4–0.8 mm) apical yellow collar; flowers in late June and produces mature achenes from late July through early August.

DISTRIBUTION: Black Hills region of South Dakota and adjacent Wyoming. The species is disjunct from this area of the United States to western Canada (Moore and Frankton, 1967). The same authors state that an 1862 collection (*Hall & Harbour 343*) from northern

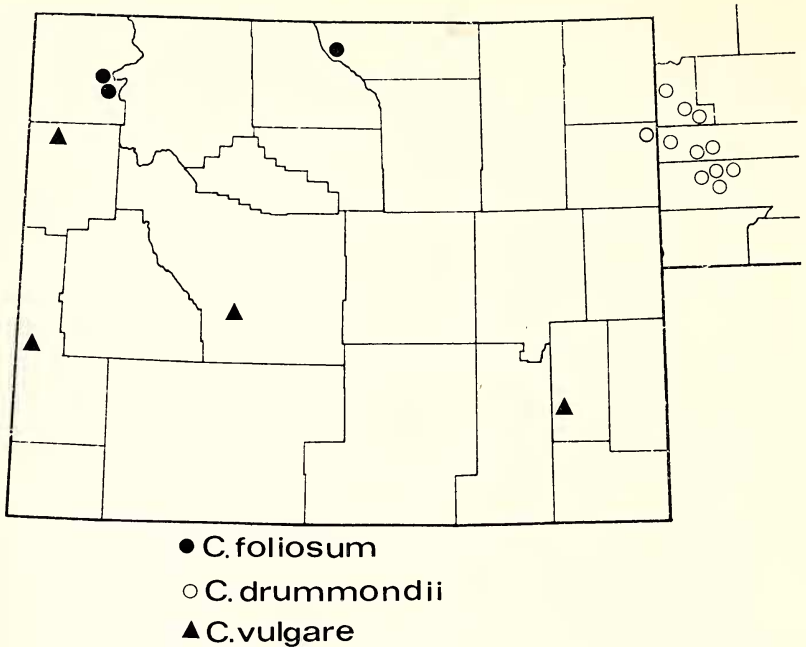


FIG. 5. Documented Wyoming distribution of *C. foliosum*, *C. drummondii* (in U. S., taxon now known only from Black Hills region), and *C. vulgare*.

Colorado is almost, if not wholly, typical of the species, and they suggest this is a relict of its range in the past. The taxon is known from two Wyoming localities (fig. 5). The locality of one collection, *A. Nelson 9442*, was visited in 1971, but the species was not found. I have not seen the other collection referred to this taxon by Moore and Frankton (1964). The locality is given as Welcome, Crook Co., Wyoming. Plants are found scattered in mesic sites, under pines and aspen; 1400–2200 m.

REPRESENTATIVE SPECIMENS: Wyoming: Weston Co.: Boyd, 19 Jul 1910, *A. Nelson 9442*.

*Cirsium drummondii* is distinct from all Wyoming thistles. Traditionally the species has been included in Rydberg's (1917) sect. *Foliosa*, based on the following features: heads usually in compact terminal cluster, stem simple, leaves clasping, and innermost phyllaries lacerate along the margins. The taxon does not "fit" sect. *Foliosa* due to the following characteristics: heads not noticeably exceeded by upper cauline leaves, some of the phyllaries glandular, and achenes with broad apical yellow collars; these features are characteristic of Rydberg's (1917) sect. *Undulata*. Leaf flavonoid data also suggest a similarity to the latter section (fig. 2; Tables 2 and 3). The conflicting morphological and chemical information listed above indicate the necessity for additional study to determine the closest affinities of the taxon.

4. *CIRSIUM FOLIOSUM* (Hooker) DC., Prodr. 6:654. 1838.—*Carduus foliosus* Hooker, Flora Bor. Amer. 1:303. 1833. TYPE: Canada: Alberta: "Prairies of the Rocky Mountains," *Drummond s.n.* (Holotype: K, not seen).—*Cnicus foliosus* (Hooker) A. Gray, Proc. Amer. Acad. Arts 10:40. 1874.

Plants 4–6 dm tall, stems simple; heads subtended by one to several leaves (lower leaves 15–20 cm long, 2–4 cm wide, sinus depth 60–67% of leaf width, subtending leaves 10–15 cm long, 0.5–1.0 cm wide, sinus depth 50% of leaf width), leaf bases slightly clasping, marginal spines 4–7 mm long, generally longest on subtending leaves; heads axillary on upper fourth of stem, clustered, involucre 1.9–2.5 cm tall, 1.5–2.0 cm broad, about as broad as tall, with 5–7 rows of phyllaries, nonglandular, outermost with hairs along margins; pappus 21–25 mm long, exceeding the corolla by at least 1 mm; corolla white, 19–23 mm long, the lobes 3–4 mm long; anthers 4–6 mm long; style 23–26 mm long, the branches 2–3 mm long; achenes 4 mm long, less than 2 mm wide, with a narrow yellow apical collar; flowers in late July, producing mature achenes from middle to late August.

DISTRIBUTION: northern Wyoming and adjacent Montana. Moore and Frankton (1964) indicate that it extends through western Montana, and is also known from Canada. In Wyoming (fig. 5), it is found in moist meadows and clearings; 2500–2640 m.

REPRESENTATIVE SPECIMENS: Wyoming: Sheridan Co.: Hwy. 14 alternate, 4 mi W of Burgess Jct., 9 Aug 1971, *Gardner 191*. Yellowstone National Park: Sylvan Pass, 25 Aug 1951, *Senn, Frankton & Gillett 5681* (DAO); 11 mi W of E entrance, 10 Aug 1971, *Gardner 194*.

Moore and Frankton (1967) state that *C. foliosum* is self fertile and that in the "change" from an outbreeder the corolla and anthers became smaller while the pappus retained its original length. They also suggest that *C. foliosum* arose from *C. scariosum*. The two taxa overlap considerably in corolla and anther length, however, it is the pappus length that best separates them. This suggests that rather than a reduction in the corolla and anther length of *C. foliosum* there has been an increase in the length of the pappus.

5. *CIRSIUM UNDULATUM* (Nutt.) Spreng., Syst. Veg. 3:374. 1826.—*Carduus* (§ *Cnicus*) *undulatus* Nutt., Gen. North Amer. Plants 130. 1818. TYPE: "... Lake Huron, and on the plains of the Upper Louisiana", *Nuttall s.n.* (Holotype: GH, not seen).—*Cnicus undulatus* (Nutt.) A. Gray, Proc. Amer. Acad. Arts 10:42. 1874.

*Cnicus undulatus* (Nutt.) A. Gray var. *megacephalus* A. Gray, Proc. Amer. Acad. Arts 10:42. 1874. TYPE: none cited.—*Cnicus megacephalus* (A. Gray) Cockerell ex Daniels, Univ. Missouri Studies, Sci. Ser. 2(2):402. (Oct) 1911. For a more complete listing of synonymy, cf. Ownbey (1952).

Plants 4.5–8.0 dm tall, stems simple below, branching above; lower leaves 25–35 (–50) cm long, 6–10 cm wide, upper leaves 5–7 cm long, 2–4 cm wide, leaf bases clasping or decurrent (–12 mm), both leaf surfaces grayish, tomentose, more densely so below; heads terminating the branches (usually 1/branch), involucre 2.3–3.5 cm tall, 2–3 cm broad, almost as broad as tall, with 8–10 rows of phyllaries, glandular with light pubescence along margins; pappus 25–30 mm long; corolla pink to purple, 34–40 mm long, the lobes 9–10 mm long; anthers 12–14 mm long; style 36–42 mm long, the branches 5–6 mm long; achenes 6 mm long, 2–3 mm wide, with or without a narrow yellow apical collar; flowers in early July, producing fruits from late July throughout August.

**DISTRIBUTION:** Michigan to Texas and Arizona to British Columbia. In Wyoming (fig. 6), the taxon is a roadside weed and occasionally is found in fields and pastures; 1130–2720 m.

**REPRESENTATIVE SPECIMENS:** Wyoming: Albany Co.: Laramie, City Park, 2 Oct 1894, *A. Nelson 1156*; Hwy. 34, 6 mi E of Morton's Pass, 2 Jul 1971, *Gardner 118*. Campbell Co.: near Spotted Horse, 24 Jul 1958, *Porter & Porter 7580*. Crook Co.: 17 mi S of Sundance, Inyankara

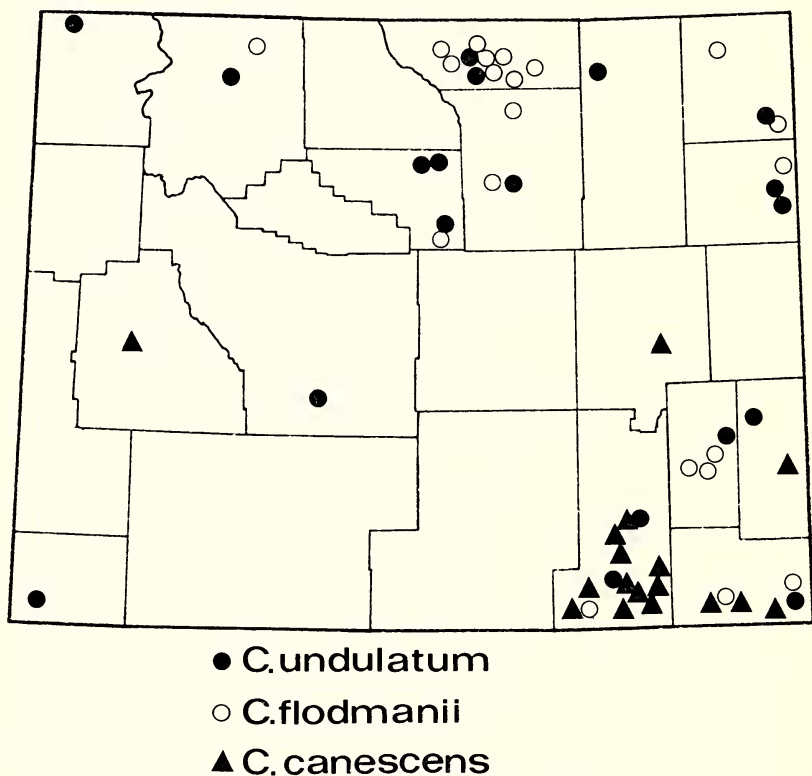


FIG. 6. Documented Wyoming distribution of *C. undulatum*, *C. flodmanii*, and *C. canescens*.

Creek, 14 Jul 1927, *Hayward 2138*. Fremont Co.: Hwy. 287-789, 5 mi E of jct. with Hwy. 28, 17 Aug 1971, *Gardner 213*. Goshen Co.: Haystack Range, 8 Jul 1955, *C. L. Porter 6746*. Johnson Co.: Hwy. 87, 14 mi S of Buffalo, 9 Aug 1971, *Gardner 187*. Laramie Co.: Pine Bluffs, 5 Jul 1897, *A. Nelson 3506*. Park Co.: Sunlight Valley, Crandall Creek road, 23 Aug 1924, *Pearson & Pearson 196*. Platte Co.: Hwy. 317, Lake Guernsey State Park, 2 Jul 1971, *Gardner 120*. Sheridan Co.: between Sheridan & Buffalo, 15 Jun-15 Jul 1900, *Tweedy 3049*; Hanna Creek, 28 Jun 1909, *Vie Willits 195*. Unita Co.: Evanston, Jul-Aug 1938, *Myroie 3*. Washakie Co.: Hwy. 16, 13 mi NE of Tensleep, 16 Aug 1961, *Ownbey & Ownbey 3036*; Hwy 16, 25 mi E of Tensleep, 7 Jul 1971, *Gardner 130*. Weston Co.: Newcastle, 9 Jul 1927, *Hayward 2010*; Hwy. 16, 1 mi NW of Wyoming-South Dakota border, 5 Aug 1971, *Gardner 175*. Yellowstone National Park: Mammoth Hot Springs, 20 Jul 1899, *A. & E. Nelson 6027, 6028*.

The most useful character in separating *C. undulatum* and the somewhat similar *C. flodmanii* is the presence of a wide apical collar on the achenes of *C. flodmanii*. This collar is very narrow or lacking in *C. undulatum*. Other characters include rosette leaves entire, upper leaf surface greenish, for *C. flodmanii*, and rosette leaves divided, upper leaf surface grayish, for *C. undulatum*. Frankton and Moore (1961) state that the hairs on the filaments of *C. flodmanii* are longer and denser than those of *C. undulatum*.

6. *CIRSIUM FLODMANII* (Rydb.) Arthur, *Torreyia* 12:34. 1912.—*Carduus flodmanii* Rydb., *Mem. New York Bot. Gard.* 1:451. 1900. TYPE: Montana: East Gallatin Swamps, 1896, *Flodman 879*. (Holotype: NY, not seen).

*Carduus oblanceolatus* Rydb., *Bull. Torrey Bot. Club* 28:510-511. 1901. TYPE: Colorado: Twin Lakes, 1896, *F. Clements 385*. (Holotype: NY?, not seen). *Cirsium oblanceolatum* (Rydb.) K. Schum., *Bot. Jahresber. (Just)* 29(1):566. 1903.—*Cirsium flodmanii* (Rydb.) Arthur f. *oblanceolatum* (Rydb.) D. Löve & Bernard, *Svensk Bot. Tidskr.* 53(4):450-451. 1959.

Plants 3.5-7.0 dm tall, stems simple below (rarely two or three from the same rootstock), branching above; lower leaves 28-33 cm long, 3-8 cm wide, usually at least one rosette leaf is entire, leaf bases clasping, lower leaf surfaces grayish, upper surfaces green, glabrous or with thin tomentum; heads terminating the branches (usually 1/branch) involucre 2.1-3.5 cm tall, 1-2 cm broad, about half as broad as tall, with 8 rows of phyllaries, glandular, outermost arachnoid pubescent, inner ones hairy along margins; pappus 25 mm long; corolla purple, 28-31 mm long, the lobes 6-7 mm long; anthers 9-11 mm long; style 31-32 mm long, the branches 5-6 mm long; achenes 4-5 mm long, 2 mm wide, with a broad (0.4-0.7 mm) yellow apical collar; flowers from June to August and producing mature achenes throughout August.



**DISTRIBUTION:** Colorado to northeastern Iowa and from Colorado and Iowa into Canada. In Wyoming (fig. 6), the species occurs mainly in moist areas, where land is irrigated and/or cultivated; 1100–2100 m.

**REPRESENTATIVE SPECIMENS:** Wyoming: Albany Co.: Cummins, 30 Jul 1895, *A. Nelson 1563*. Big Horn Co.: Red Banks, 22 Jul 1901, *Goodding 335*. Crook Co.: Inyankara Mt., 21 Aug 1897, *Griffiths s.n.* (RM-70552); New Haven, 2 Aug 1924, *Kendall 10776*. Johnson Co.: Hwy. 16, 3 mi NE of Buffalo, 7 Jul 1971, *Gardner 136A* (flower), *136B* (bud); Hwy. 87, 23 mi S of Buffalo, 9 Aug 1971, *Gardner 186*. Laramie Co.: Cheyenne, 11 Aug 1891, *Buffum s.n.* (RM-1838); near Pine Bluffs, on Spring Creek, 14 Aug 1959, *Porter & Porter 8028*. Park Co.: Clark's Fork Valley, Little Rocky Crossing, 24 Aug 1924, *Pearson & Pearson 202, 203*. Platte Co.: Wheatland, 2 Sep 1903, *A. Nelson 8981*; Hwy. 87, 1.8 mi N of Wheatland, 13 Sep 1959, *Ownbey & Ownbey 1304*. Sheridan Co.: Sheridan, 10 Jul 1896, *A. Nelson 2272*; between Sheridan and Buffalo, 15 Jun–15 Jul 1900, *Tweedy 3050*; 5 mi NW of Big Horn, road between Big Horn and Becton, 9 Aug 1971, *Gardner 188*. Weston Co.: Near old Boyd Townsite, E of Four Corners Store, 9 Aug 1971, *Gardner 176*.

*Carduus oblanceolatus* Rydb. was described as being closest to *C. flodmanii*, differing in the narrower phyllaries, and all leaves being entire. D. Löve and Bernard (1959) considered it to be only a form of *C. flodmanii* and made the transfer as forma *oblanceolatum* (Rydb.) D. Löve & Bernard. The plants that "fit" forma *oblanceolatum* have the same geographical distribution as *C. flodmanii*. In Wyoming specimens, a continuous variation is seen, and I feel there is no taxonomic value in recognizing f. *oblanceolatum*.

7. **CIRSIIUM OCHROCENTRUM** A. Gray, Mem. Amer. Acad. Arts (n.s.) 4:110. 1849. TYPE: New Mexico: Mountain-sides, around Santa Fe, Jul?, *Fendler 486*. (Holotype: GH, not seen).—*Cnicus ochrocentrus* (A. Gray) A. Gray, Proc. Amer. Acad. Arts 19:57. 1883.—*Carduus ochrocentrus* (A. Gray) Greene, Proc. Acad. Nat. Sci. Philadelphia 1892:363. 1893.—*Cnicus undulatus* Nutt. var. *ochrocentrus* (A. Gray) A. Gray, Proc. Amer. Acad. Arts 10:42–43. 1874.—*Carduus undulatus* Nutt. var. *ochrocentrus* (A. Gray) Rydb., Contr. U. S. Natl. Herb. 3:510. 1896.

Plants 4.0–7.6 dm tall, stems simple below (rarely two from a single root), branching above; lower leaves 12–22 cm long, 2.5–3.5 cm wide, upper leaves 5–6 cm long, 1–2 cm wide, leaf bases decurrent, usually greatest on upper leaves, the wings 20–25 mm long near stem apex, 8–17 mm long near ground level; heads terminating the branches (usually 1/branch), involucre 3.0–3.5 (–4.2) cm tall, 1.5–2.5 cm broad, 1/2 to 2/3 as broad as tall, with 7 or 8 rows of phyllaries, obscurely glandular, with light pubescence along margins; pappus 27–30 mm long; corolla



white to pink, 34–38 mm long, the lobes 8–9 mm long; anthers 11–13 mm long; style 35–45 mm long, the branches 5–7 mm long; achenes 6–7 mm long and 2.5–3.0 mm wide, with or without a narrow yellow apical collar; flowers in mid-August, and produces mature achenes by the end of the month.

**DISTRIBUTION:** Nebraska to Texas and Arizona. In Wyoming (fig. 7), the species is often seen as a roadside weed, and in fields in relatively dry sites; 1320–2100 m.

**REPRESENTATIVE SPECIMENS:** Wyoming: Albany Co.: Hwy. 30, 8 mi NW of Rock River, 9 Aug 1971, *Gardner 182*. Carbon Co.: Hwy. 30, 2 mi SE of Medicine Bow, 9 Aug 1971, *Gardner 183*. Fremont Co.: Hwy. 287–26, 7.9 mi SE of Crowheart, 16 Aug 1961, *Ownbey & Ownbey 3037*; Hwy. 26–287, 17 mi NW of Lander, 12 Aug 1971, *Gardner 209*. Goshen Co.: Fort Laramie, 26 Jul 1908, *A. Nelson 9196*; Hwy. 85, 15 mi N of Lingle, 5 Aug 1971, *Gardner 177*. Laramie Co.: 7 mi W of Cheyenne and 1 mi N of Hwy. US 30, 11 Aug 1958, *Jean Finzel 109*; Hwy. I-25, 15 mi S of Chugwater, 30 Jul 1971, *Gardner 155*. Niobrara Co.: Manville, 31 Aug 1944, *Pfadt s.n. (RM-197375)*. Platte Co.: Hwy. 34, 3 mi

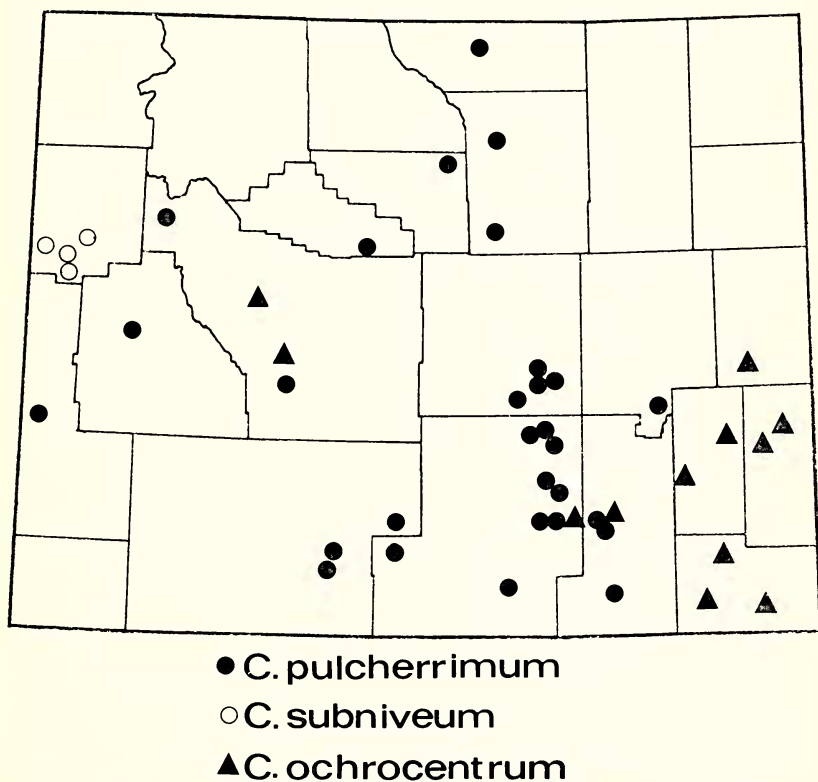


FIG. 7. Documented Wyoming distribution of *C. pulcherrimum*, *C. subniveum*, and *C. ochrocentrum*.

E of Sybille Creek, 2 Jul 1971, *Gardner 119*; Hwy. 26, 12 mi E of jct. with Hwy. I-25, 2 Jul 1971, *Gardner 121* (3.5 dm tall), 122 (7 dm tall).

With decurrent leaves, involucre 3 cm or more tall, and broad triangular phyllaries tipped by stout spines, this taxon is almost impossible to confuse with any other Wyoming thistle. The cauline leaves appear slightly wilted and seem to droop. This feature is particularly useful in the field, but is often obscured on mounted specimens.

8. *CIRSIUM CANESCENS* Nutt., Trans. Amer. Philos. Soc. 7:420. 1841. TYPE: "Arid plains of upper Platte", *Nuttall s.n.* (Holotype: BM, not seen).

*Cnicus nelsoni* Pammel, Proc. Iowa Acad. Sci. 8:235. 1901. TYPE: Wyoming: Albany Co.: Laramie, Aug 1900, *A. Nelson 8093*. (Holotype: ISC, not seen; Isotype: RM!).—*Carduus nelsonii* (Pammel) A. Nelson in Coulter and Nelson, Manual Bot. Rocky Mts. 586. 1909.—*Cirsium nelsoni* (Pammel) Petrak, Beih. Bot. Centralbl. 35(2):552. 1917.—*Circium nelsonii* (Pammel) Rydb., Flora Rocky Mts. and Adjacent Plains 1012, 1069. 1917. For a more complete listing of synonymy, cf. Ownbey (1952).

Plants 4.0–6.5 (–9) dm tall, stems simple below, branching above; lower leaves 18–32 cm long, 5–8 cm wide, upper leaves 3–7 cm long, 0.3–2.0 cm wide, leaf bases decurrent, usually greatest on upper leaves, the wings 17–25 mm long near stem apex, 5–22 mm long near ground level; heads terminating the branches (usually 1/branch), involucre 1.8–2.6 cm tall, and 1.8–2.6 cm broad, about as broad as tall, with 6–8 rows of phyllaries, glandular, with light pubescence along margins; pappus 19–21 mm long; corolla white (rarely pink to purple), 24–28 mm long, the lobes 6 mm long; anthers 9.5–10.0 mm long; style 26–33 mm long, the branches 5–6 mm long; achenes 5–7 mm long, 2.5 mm wide, with or without a narrow yellow apical collar; flowers in late June to late July and produces mature achenes from late July to late August.

DISTRIBUTION: Saskatchewan to Iowa, west to Wyoming, Utah and New Mexico. In the state (fig. 6), it is found as a roadside weed in dry habitats; 1560–2560 m.

REPRESENTATIVE SPECIMENS: Wyoming: Albany Co.: Laramie Hills, 7 Jul 1894, *A. Nelson 414*; Jelm, "Plains and Foothills", *A. Nelson 8071* (Paratype of *Cnicus nelsoni* Pammel, RM!). Converse Co.: 0.7 mi N of Douglas, 21 Jul 1951, *Ownbey & Ownbey 1572*. Fremont Co.: Porcupine, Wind River, *T. A. Williams s.n. (RM-68200)*. Goshen Co.: Hwy. 26, 4.9 mi NW of Lingle, 20 Jul 1951, *Ownbey & Ownbey 1567*. Laramie Co.: Hwy. I-80, 7 mi W of Cheyenne, 20 Jul 1971, *Gardner 156A*; Hwy. 214, 1 mi S of Hwy. I-80 Burns-Carpenter exit, 3 Aug 1971, *Gardner 168*. Sublette Co.: Hwy 189, 10 mi N of Big Piney, 10 Aug 1971, *Gardner 204A*.

*Cirsium canescens* is characterized by decurrent leaves, involucre

about as broad as tall, lobes of lower leaves 3.5–5.0 times longer than broad, and short (usually less than 4 cm long) spines on the phyllary tips. It is most commonly confused with *C. pulcherrimum*. The latter taxon is differentiated by involucre about half as broad as tall, lobes of lower leaves 3.0 or less times longer than broad, and phyllary spines 5 mm or more long.

9. *CIRSIUM PULCHERRIMUM* (Rydb.) K. Schum., Bot. Jahresber. (Just) 29(1):566. 1903.—*Carduus pulcherrimus* Rydb., Bull. Torrey Bot. Club 28:510. 1901. TYPE: Wyoming: Headwaters of Clear Creek and Crazy Woman River, 1900, *Tweedy 3048*. (Holotype: NY, not seen; Isotype: RM!).

Plants 4.5–6.0 (–8.0) dm tall, stems simple below, branching above, frequently several stems from one rootstock; lower leaves 12–22 cm long, 1.5–6.0 cm wide, upper leaves 4–7 cm long, 0.5–2.5 cm wide, leaf bases decurrent, usually greatest on upper leaves, the wings 15–35 mm long near stem apex, 4–17 mm near ground level, lower leaf surfaces grayish, upper surfaces green or with scattered tufts of hair; heads terminating the branches, but occasionally sessile in axils of middle cauline leaves, involucre 1.8–2.7 cm tall, 1.0–1.5 (–2.0) cm broad, 1/2 to 2/3 as broad as tall, with 6 or 7 rows of phyllaries, glandular, glabrous to pubescent along margin; pappus 15–18 mm long; corolla pink to purple, 18–25 mm long, the lobes 4–6 mm long; anthers 7–9 mm long; style 21–24 (–26) mm long, the branches 3–5 mm long; achenes 5–6 mm long, 2–3 mm wide, with a narrow yellow apical collar; flowers in late June to late July, producing fruits from early July to early August.

DISTRIBUTION: Frequent in Wyoming (fig. 7), as a roadside weed and less commonly in pastures and fields; 1440–2800 m. The distribution outside Wyoming is poorly known, since the taxon has generally been included in *C. subniveum* (see discussion below).

REPRESENTATIVE SPECIMENS: Wyoming: Albany Co.: Medicine Bow, 1898, *E. Nelson 4396*, (Paratype: RM!); Hwy. 30, 8 mi NW of Rock River, 9 Aug 1971, *Gardner 181*. Carbon Co.: 7 mi N of Medicine Bow, 9 Aug 1971, *Gardner 185*; 5 mi NW of Shirley Basin townsite, 6 Jul 1971, *Gardner 126A-D* (leaf pubescence variable). Converse Co.: 8 mi SW of Esterbrook, road to Fort Fetterman Road, 2 Jul 1971, *Gardner 123*. Fremont Co.: 10 mi S of Lander, Brown Canyon, 24 Jul 1961, *Fisser 636*; Hwy. 26–287, 10 mi W of Dubois, 12 Aug 1971, *Gardner 208*. Hot Springs Co.: 30 mi SE of Thermopolis, 8 Jul 1958, *Allen s.n.* (RM-28800-s). Johnson Co.: Hwy. 16, 10 mi W of Buffalo, 15 Aug 1961, *Owney & Ownbey 3029A*; 12 mi S of Hwy. I-25, on TTT Ranch Road, 7 Jul 1971, *Gardner 140*. Lincoln Co.: E of Smoot, near Cottonwood Lake, 28 Jul 1923, *Payson & Armstrong 3614*. Natrona Co.: Casper Mtn., Circle Drive, 9 Aug 1957, *C. L. Porter 7417*; Hwy. 487, 10 mi S of jct. with Hwy. 220, 6 Jul 1971, *Gardner 127*. Sheridan Co.: Upper Grade, 9 Jul 1909, *Vie Willits 276*; Bondi Camp, W of Sheridan, 7 Aug

1938, *Hapeman s.n.* (RM-223374). Sublette Co.: Hwy. 189, 10 mi N of Big Piney, 10 Aug 1971, *Gardner 204B*. Sweetwater Co.: Bitter Creek, 12 Jul 1897, *A. Nelson 3529*; Hwy. 789, 5 mi S of Creston Jct., 22 Jul 1971, *Gardner 153*. Washakie Co.: Hwy. 16, 30 mi E of Tensleep in Tensleep Canyon, 7 Jul 1971, *Gardner 131 & 132*; Hwy. 16, 15 mi W of Buffalo, 7 Jul 1971, *Gardner 134 & 135*.

Rydberg (1917) recognized *C. pulcherrimum* and *C. subniveum* as distinct species. Since then, the binomial *Cirsium pulcherrimum* seldom appears either in the literature or on herbarium labels, the plants mostly being referred to *C. subniveum*. Cronquist (1955) includes *C. subniveum* in his treatment, but concludes the specimens he has seen differ from the type of *C. subniveum* in being less densely hairy, and that possibly his plants need another name. After studying the type material of both taxa, Moore and Frankton (1963) suggested that there is some justification for relegating *C. subniveum* to synonymy under *C. pulcherrimum*. However, they point out that the type of the former taxon has been damaged by insects and that corolla and pappus characters are obscure, while achenes, anthers, and styles are not available. Isotypes of both taxa are deposited at RM, and have not been damaged by insects, thus structures that are obscure or lacking on the holotypes are in excellent condition on these isotypes. Although the two taxa are not distinct in every character, it is possible to distinguish them by considering a combination of features. *Cirsium pulcherrimum* is characterized by having the decurrence of the upper leaves greater than, or equal to, that of the lower leaves, while the reverse is true in *C. subniveum*, i.e., the lower leaves are always more decurrent than the upper ones. In addition to the floral characteristics used to separate the two taxa (fig. 8), *C. pulcherrimum* has generally longer phyllaries and spines, while *C. subniveum* is more densely hairy on the leaf surfaces and on the phyllaries. In Figure 8 the specimen represented near coordinates  $10 \times 25$  falls within the range of *C. subniveum*. Characteristics not plotted that indicate that this gathering is *C. pulcherrimum* include glabrous upper leaf surface and phyllaries, and decurrence of upper leaves greater than that of the lower ones. By combining these morphological data with the chemical data, this collection is unquestionably *C. pulcherrimum*.

Both taxa have  $2n = 34$  (Moore and Frankton, 1963; Ownbey and Hsi, 1969; Table 1). Ownbey and Hsi (1963) give  $2n = 32$  for *C. subniveum*, but question the proper identification of the specimen from which the count was obtained. *Cirsium subniveum* (fig. 1) has six satellite chromosomes, while *C. pulcherrimum* (fig. 1) apparently has none. The species are also distinct chemically (fig. 2).

10. *CIRSIMUM SUBNIVEUM* Rydb., Flora Rocky Mts. and Adjacent Plains 1006, 1068. 1917. TYPE: Wyoming: Teton Co.: Jackson's Hole, 21 Aug 1894, *A. Nelson 1070*. (Holotype: US, not seen; Isotype: RM!)

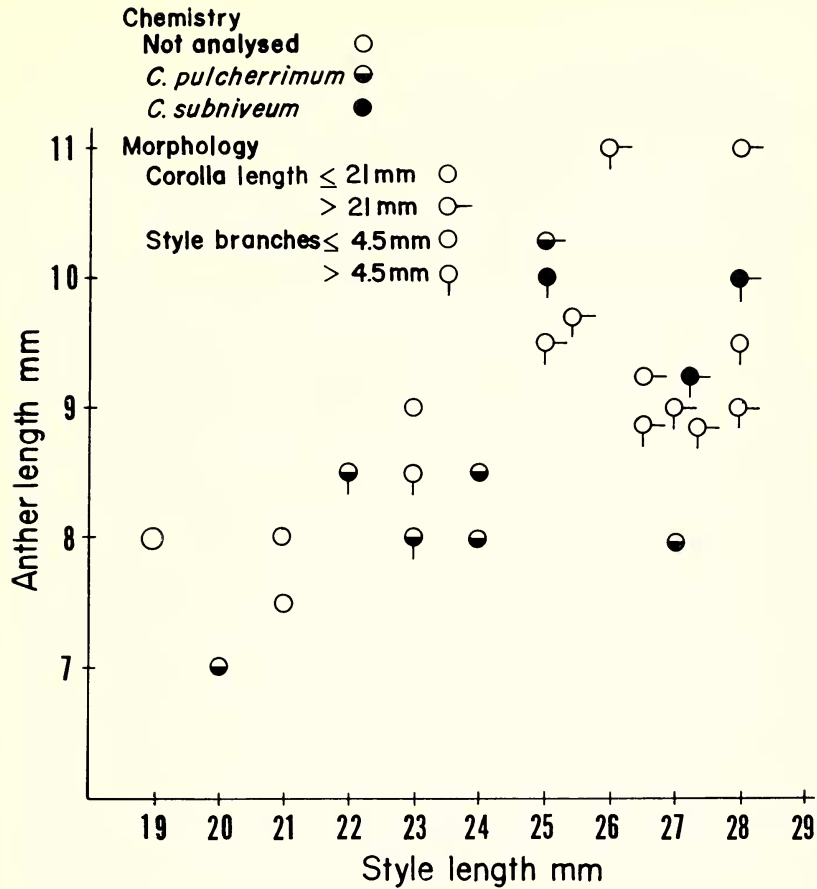


FIG. 8. Scatter diagram of morphological and chemical characteristics of *Cirsium pulcherrimum* and *C. subniveum*.

Plants 3.5–8.0 dm tall, stems simple below, branching above; lower leaves 20–25 cm long, 3–5 cm wide, all leaves more or less decurrent, this most pronounced on the lower ones, the wings 5–10 mm long near stem apex, 25–40 mm long near ground level, both leaf surfaces tomentose, the tomentum becoming somewhat looser on upper surfaces; heads terminating the branches, but occasionally sessile in axils of cauline leaves, involucre 1.8–2.4 cm tall, and 1.0–1.6 cm broad, about half as broad as tall with 5–7 rows of phyllaries, glandular or not, arachnoid pubescent; pappus 15–20 mm long; corolla white to purple, 20–26 mm long, the lobes 3–4 mm long; anthers 9–11 mm long; style 26–33 mm long, the branches 4–6 mm long; achenes 5.5–6.5 mm long, 2.0–2.5 mm wide, with a narrow yellow apical collar; flowers in late July through early August, producing fruits from mid-August onward.

DISTRIBUTION: Oregon, Nevada, and central Idaho to northwestern



Wyoming. In Wyoming (fig. 7), the habitat of the species is variable, as it was collected under *Populus* and *Salix* in one area and as a roadside weed in another; 1880–2100 m.

REPRESENTATIVE SPECIMENS: Wyoming: Grand Teton National Park: Gros Ventre Campground, 10 Aug 1971, *Gardner 199*. Sublette Co.: 20 mi W of Big Piney, 11 Jul 1922, *Payson & Payson 2656*. Teton Co.: 3 mi NE of Jackson, 17 Aug 1961, *Ownbey & Ownbey 3040*; jct. Hwys. 26–89 & 187–189, Hoback Jct., 10 Aug 1971, *Gardner 200*.

11. *CIRSIIUM TWEEDYI* (Rydb.) Petrak, Beih. Bot. Centralbl. 35(2):560. 1917.—*Carduus tweedyi* Rydb., Mem. New York Bot. Gard. 1:499. 1900. TYPE: Montana: Park Co.: 1887, *Tweedy 350*. (Holotype: NY, not seen).

*Cirsium hookerianus* (Nutt.) Heller var. *eriocephalus* A. Nelson in Coulter and Nelson, Manual Bot. Rocky Mts. 585. 1909. *pro parte*. *Carduus polyphyllus* Rydb., Bull. Torrey Bot. Club 37:542. 1910. TYPE: Montana: Mountains near Indian Creek, 21 Jul 1896, *Rydberg & Bessey 5216*. (Holotype: NY, not seen).—*Cirsium polyphyllum* (Rydb.) Petrak, Beih. Bot. Centralbl. 35(2):556. 1917.

Plants (1.5–) 2.0–4.5 (–6.0) dm tall, stems simple; lower leaves 19–23 cm long, 2–4 cm wide, subtending leaves 4–11 cm long, 0.5–1.0 (–1.3) cm wide, leaf bases decurrent, wings to 30 mm long; heads clustered near stem apex, rarely axillary on upper half of plant, involucre 1.5–3.0 cm tall, and 1.0–1.5 cm broad, 1/2 to 2/3 as broad as tall, with 5–7 rows of phyllaries, nonglandular (one specimen seen with a few glandular phyllaries), the outermost rows arachnoid pubescent (this occasionally true of all phyllaries) or rarely glabrous; pappus 10–18 mm long; corolla white to pink, 16–25 mm long, the lobes 5–7 mm long; anthers 8–9 mm long; style 21–29 mm long, the branches 4.5–5.0 mm long; achenes 6 mm long, 2 mm wide, with or without a narrow yellow apical collar; flowers in early August and produces mature achenes from late August through early September.

DISTRIBUTION: northern Colorado through Wyoming to north central Montana and west to adjacent Idaho. In Wyoming (fig. 9), the species is found on disturbed, usually gravelly soils; 2130–3450 m.

REPRESENTATIVE SPECIMENS: Wyoming: Big Horn Co.: Medicine Wheel, 1 Aug 1931, *Solheim 463*; Hwy. alternate 14, 35 mi E of Lovell, road to Medicine Wheel, 9 Aug 1971, *Gardner 192*. Fremont Co.: Two Ocean Mt., 10,000 ft, 9 Sep 1948, *Reed & Reed 2568*; Gannett Peak area, W of Dinwoody Creek, 12,000 ft, 6 Aug 1963, *Jozwik 474*. Grand Teton National Park: W of Jenny Lake, Mt. Woodring, 9 Aug 1963, *Merkle 63–72*. Park Co.: Hwy. 312, 17.6 mi SW of Montana-Wyoming state line, 2 Sep 1961, *Ownbey & Ownbey 3073*. Sheridan Co.: Little Goose Creek Hills, 16 Jul 1896, *A. Nelson 2339*; Hwy. 14, 8 mi E of Burgess Jct., 9 Aug 1971, *Gardner 190*. Sublette Co.: Green River Lakes,



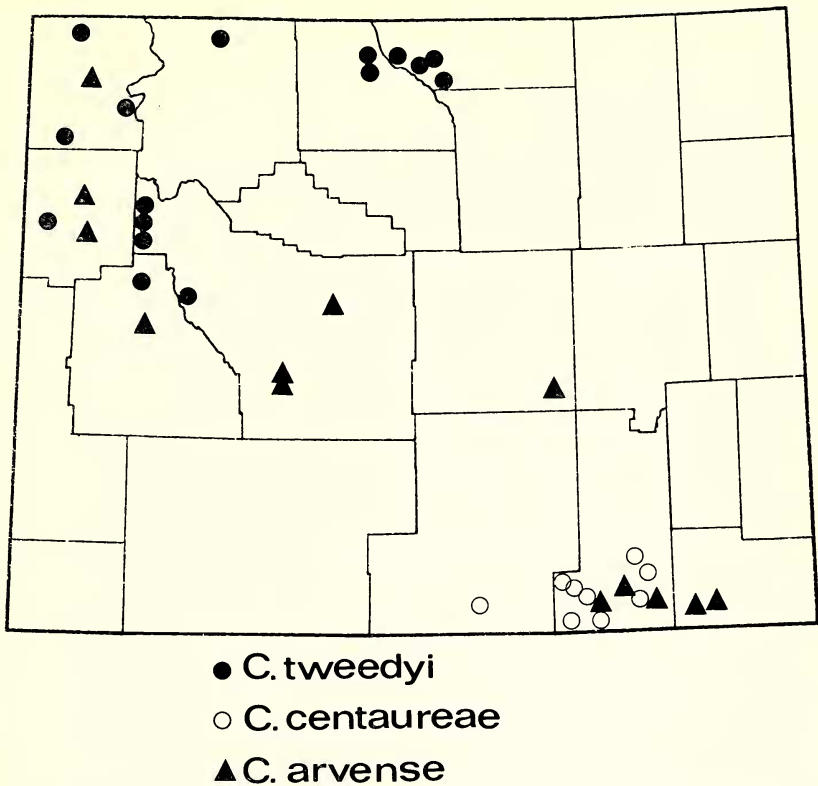


FIG. 9. Documented Wyoming distribution of *C. tweedyi*, *C. centaureae*, and *C. arvense*.

White Rock Mt., 8 Aug 1925, *Payson & Payson* 4610. Yellowstone National Park: Snake River, 12 Aug 1899, *A. & E. Nelson* 6419; 5.5 mi W of east entrance, E side of Sylvan Pass, near summit, 10 Aug 1971, *Gardner* 195.

*Cirsium tweedyi* is apparently the only species of Rydberg's (1917) sect. *Eriocephala* in Wyoming. Moore and Frankton (1965) suggest that *C. scopulorum* (Greene) Cockerell may reach the south central portion of the state, but attempts to find it west of Encampment in the Sierra Madre Range were unsuccessful. A third species, *C. polyphyllum*, has been reported from northwestern Wyoming. This species is reported from the same habitats and general distribution as *C. tweedyi* and morphologically the two intergrade considerably. Moore and Frankton (1965) place these species in synonymy, a conclusion with which I agree.

12. *CIRSIIUM CENTAUREAE* (Rydb.) K. Schum., Bot. Jahresber. (Just) 29(1):566. 1903.—*Carduus centaureae* Rydb., Bull. Torrey Bot.

Club 28:507. 1901. TYPE: Colorado: Larimer Co.: [as Laramie Co.] 1895, *J. H. Cowen s.n.* (Holotype: NY, not seen).—*Cirsium centaureae* (Rydb.) Cockerell ex Daniels, Univ. Missouri Studies, Sci. Ser. 2(2):402. (Oct.) 1911. (Note: combination already made by K. Schum., 1903.)

*Cnicus carlinoides* Schrank var. *americanus* A. Gray, Proc. Amer. Acad. Arts 10:48. 1874. TYPE: Colorado Territory: Rocky Mts., *Hall & Harbour* 342. (Holotype: GH?, not seen).—*Cnicus americanus* (A. Gray) A. Gray, Proc. Amer. Acad. Arts 19:56. 1884.—*Carduus americanus* (A. Gray) Greene, Proc. Acad. Nat. Sci. Philadelphia 1892:363. 1893.—*Cirsium americanum* (A. Gray) Daniels, Univ. Missouri Studies, Sci. Ser. 2(2):401. (Oct.) 1911. non K. Schum., 1903.

Plants (3.0–) 6.0–8.5 dm tall, stems simple or several from the base, branching above; lower leaves 19–27 cm long, 4–9 cm wide, upper leaves 5–6 cm long, 1 cm wide, leaf bases decurrent, usually greatest on upper leaves, wings 25–35 mm long near stem apex, 10–17 mm long near ground level; heads terminating the branches (usually 1/branch), involucre 1.9–2.7 cm tall, 0.8–1.3 cm broad, about half as broad as tall, with 5–7 rows of phyllaries, margins membranous and lacerate, non-glandular; pappus 10–18 mm long; corolla white to pink, 16–23 mm long, the lobes 4–5 mm long; anthers 8–10 mm long; style 10–18 mm long, the branches 4–5 mm long; achenes 5.5–8.0 mm long, 2.0–2.5 mm wide, with or without a narrow yellow apical collar; flowers in late July, producing mature achenes throughout August.

DISTRIBUTION: California, Oregon, and Washington, and also from Utah, Colorado, and Wyoming. In Wyoming (fig. 9), the taxon is found in moist sites, under deciduous trees and rarely as a roadside weed; 2320–3130 m.

REPRESENTATIVE SPECIMENS: Wyoming: Albany Co.: Cummins, 29 Jul 1895, *A. Nelson* 1512; County road 17, 5 mi SE of quarry, 19 Jul 1971, *Gardner* 143. Carbon Co.: Bridger Peak, 24 Aug 1903, *Goodding* 2009.

*Cirsium centaureae* is easily recognized by its broadly dilated, lacerate phyllaries, freely branched stem, and leaf bases that are strongly decurrent, with laterally expanded wings.

13. *CIRSIIUM VULGARE* (Savi) Airy-Shaw, Fedde Rep. Sp. Nov. 43:303. 1938.—*Carduus vulgaris* Savi, Flora Pisana 2:241. 1798. (Pisa, Italy) (Holotype: none cited). For a more complete listing of synonymy cf. Cronquist (1955).

Plants 6–15 dm tall, stems simple below, branching above; lower leaves 15–20 cm long, 3–5 cm wide, upper leaves 3–7 cm long, 2 cm wide, leaf bases decurrent, wings 20–35 mm long, about the same throughout plant, upper leaf surfaces green, with appressed 0.5–1.0 mm long spines

on surface; heads in clusters at ends of branches or solitary, to 5 cm tall, involucre 3.0–3.5 cm tall, 1.8–2.3 cm broad, about  $2/3$  as broad as tall, with 9–12 rows of phyllaries, all reflexed near middle, nonglandular, with light arachnoid pubescence; pappus 25–28 mm long; corolla purple, 27–33 mm long, the lobes 5–6 mm long, anthers 7–8 mm long; style 29–35 mm long, the branches 4–5 mm long, achenes 4 mm long, 1.5 mm wide, with or without a narrow yellow apical collar; flowers in late July, and produces fruits throughout August.

**DISTRIBUTION:** a European introduction, occurring over most of the United States. In Wyoming (fig. 5), the species is found as a roadside weed, in dry sites; 1440–2130 m.

**REPRESENTATIVE SPECIMENS:** Wyoming: Fremont Co.: N of Lander, 17 Sep 1941, *A. & R. Nelson 4982*. Grand Teton National Park: 6 mi N of Coulter Bay, 16 Aug 1961, *Porter & Porter 8836*. Lincoln Co.: 15 mi S of Afton, 25 Aug 1945, *C. L. Porter 3820*. Platte Co.: W of Wheatland, Palmer Canyon road, 6 Aug 1959, *Porter & Porter 8002*.

*Cirsium vulgare* is easily recognized because it is the only species in Wyoming with spines on upper leaf surfaces. The reflexed aspect of the phyllaries is also unique for Wyoming species of the genus.

14. *CIRSIUM ARVENSE* (L.) Scop., *Flora Carn.* (ed. 2) 2:126. 1772.—*Serratula arvenis* L., *Sp. Pl.* 820, 1753. TYPE: "*Habitat in Europae cultis agris*". For a more complete listing of synonymy, cf. Hegi, *Illus. Flora von Mittel-Europa*, 903. 1928.

Plants 2.5–5.5 dm tall, stems simple below, usually freely branching above; lower leaves 8–10 cm long, 2–5 cm wide, uppermost leaves greatly reduced, 1.5–2.0 cm long, 0.5–1.0 cm wide, leaf bases decurrent on lower  $2/3$  of plant (wings 10–20 mm long), upper leaves clasping; heads in loose clusters, corymbiform, involucre (0.9–) 1.2–1.7 (–2.0) cm tall, and 0.6–1.0 cm broad, about  $1/2$  as broad as tall, with 5 or 6 rows of phyllaries, glandular, with light pubescence along margins; pappus 12–23 mm long; corolla pink to purple (rarely white), 14–18 mm long, the lobes 4–5 mm long; if pappus is longer than corolla, the anthers are 1–2 mm long, if pappus is shorter than the corolla, the anthers are 4–5 mm long (apparently dioecious); style 16–19 mm long, the branches 1–2 mm long; achenes 2–4 mm long, 1.0–1.5 mm wide, with a narrow yellow apical collar; flowers from late July to early September, producing fruits from early August onward.

**DISTRIBUTION:** an introduction from Europe, the species is widespread in the United States. In Wyoming (fig. 9), it occurs in a wide range of habitats, but is usually seen as a roadside weed in dry sites; 1160–2560 m.

**REPRESENTATIVE SPECIMENS:** Wyoming: Albany Co.: 5 mi W of Laramie, 16 Aug 1947, *C. L. Porter 4394*; County road 37, 3 mi S of jct. with Hwy. 230, 6 Aug 1971, *Gardner 179*. Fremont Co.: near Lander,

20 Aug 1934, *Rollins* 765; Popo-Agie River, S of Lander city limits, 2 Aug 1965, *Scott* 593. Grand Teton National Park: 5 mi E of Hwy. 26-89, road to Kelly, 10 Aug 1971, *Gardner* 198. Laramie Co.: Cheyenne, 1901, *A. Nelson s.n. (RM-37173)*; 7 mi W of Cheyenne, 1 mi N of Hwy. US 30, 19 Aug 1959, *Jean Finzel* 395. Natrona Co.: Casper Mt., Gothmore Loop, 17 Aug 1962, *Jozwik* 312. Sheridan Co.: Sheridan Expt. Farm, Sep 1895, *Lewis* 20; Sheridan, 4 Aug 1926, *A. Nelson* 10745. Sublette Co.: 3 mi SW of Pinedale, 13 Jul 1966, *Watson* 66-17. Teton Co.: Jackson Hole Wildlife Park, 19 Aug 1947, *Reed & Reed* 1653. Yellowstone National Park: Central Plateau, 29 Aug 1967, *Taylor* 67-141.

Morphologically the species is quite distinct, producing capitula in a corymbiform capitulescence. The heads are very small, and the flowers of some apparently are functionally pistillate and have greatly reduced anthers. Others appear to have functional anthers, but I have never found mature achenes in these and question whether they have functional pistils. Usually an individual plant produces only one head type.

#### ACKNOWLEDGMENTS

The author sincerely wishes to thank Dr. D. J. Crawford, for his guidance, advice, and criticisms throughout the study; Dr. and Mrs. J. R. Reeder, for reading and criticizing the original manuscript; Dr. T. F. Stuessy, for assistance in preparing the manuscript for publication; the National Park Service for permission to collect within the boundaries of Grand Teton and Yellowstone National Parks; and the Department of Agriculture Herbarium, Ottawa, Canada, for the loan of specimens. I also acknowledge financial support from: the University of Wyoming in the form of Graduate Teaching Assistantships; National Science Foundation Grant (GB-29793X) to Dr. Crawford; and the Society of the Sigma Xi Grants-in-aid of Research. This paper is part of a Master's thesis completed at the University of Wyoming, Laramie, in June 1972.

#### LITERATURE CITED

- ALSTON, R. E. and B. L. TURNER. 1962. New techniques in analysis of complex natural hybridization. *Proc. Natl. Acad. U.S.A.* 48:130-137.
- APSIMON, J. W., N. B. HAYNES, K. Y. SIM, and W. B. WHALLEY. 1963. 5, 7, 4'-trihydroxy-3', 6-dimethoxyflavone, a pigment from *Digitalis lanata* L. *J. Chem. Soc. (London)* 1963:3780-3782.
- BELZER, N. F. and M. OWNBEY. 1971. Chromatographic comparison of *Tragopogon* species and hybrids. *Amer. J. Bot.* 58:791-802.
- CHALLICE, J. S. and A. H. WILLIAMS. 1968. Phenolic compounds of the genus *Pyrus* —II. A chemotaxonomic survey. *Phytochemistry* 7:1781-1801.
- COULTER, J. M. and A. NELSON. 1909. New manual of botany of the Central Rocky Mountains (Vascular Plants). American Book Co., New York. (*Carduus*, pp. 584-587).
- CRAWFORD, D. J. 1970. Systematic studies on Mexican *Coreopsis* (Compositae). *Coreopsis mutica*: Flavonoid chemistry, chromosome numbers, morphology, and hybridization. *Brittonia* 22:93-111.
- CRONQUIST, A. 1955. In: C. L. Hitchcock, et al., Vascular plants of the Pacific Northwest. Univ. Washington Press, Seattle. (*Cirsium*, part 5, pp. 133-148).

- DOHERTY, G. O. P., N. B. HAYNES, and W. B. WHALLEY. 1963. 5, 7, 4'-trihydroxy-6-methoxyflavone, a minor pigment from *Digitalis lanata* L. J. Chem. Soc. (London) 1963:5577-5578.
- FRANKTON, C. and R. J. MOORE. 1961. Cytotaxonomy, phylogeny, and Canadian distribution of *Cirsium undulatum* and *Cirsium flodmanii*. Canad. J. Bot. 39:21-33.
- GARDNER, R. C. 1972. Biosystematic study of *Cirsium* (Compositae) in Wyoming. M.S. Thesis: Univ. Wyoming, Laramie.
- GIANNASI, D. E. 1972. The flavonoid systematics of the genus *Dahlia* (Compositae). Ph. D. Thesis: Univ. Iowa, Iowa City.
- HARBORNE, J. B. 1965. Plant polyphenols—XIV. Characterization of flavonoid glycosides by acidic and enzymic hydrolyses. Phytochemistry 4:107-120.
- . 1967. Comparative biochemistry of the flavonoids. Academic Press, New York.
- LEVIN, D. A. 1967. Hybridization between annual species of *Phlox*: Population structure. Amer. J. Bot. 54:1122-1130.
- LÖVE, D. and J. P. BERNARD. 1959. Flora and vegetation of the Otterburne area, Manitoba, Canada. Svensk Bot. Tidskr. 53(4):335-461. (cf. pp. 450-451).
- MABRY, T. J., K. R. MARKHAM, and M. B. THOMAS. 1970. The systematic identification of flavonoids. Springer-Verlag, New York, Heidelberg, and Berlin.
- MCGOWAN, S. G. and J. W. WALLACE. 1972. Flavonoids and phenolic acids from *Cirsium lanceolatum*. Phytochemistry 11:1503-1504.
- MEARS, J. A. and T. J. MABRY. 1972. A procedure for the UV detection of hydroxyl and methoxyl groups at C<sub>6</sub> in flavones and 3-O-substituted flavonols. Phytochemistry 11:411-412.
- MOORE, R. J. and C. FRANKTON. 1963. Cytotaxonomic notes on some *Cirsium* species of the western United States. Canad. J. Bot. 41:1553-1567.
- . 1964. A clarification of *Cirsium foliosum* and *Cirsium drummondii*. Canad. J. Bot. 42:451-461.
- . 1965. Cytotaxonomy of *Cirsium hookerianum* and related species. Canad. J. Bot. 43:597-613.
- . 1967. Cytotaxonomy of foliose thistles (*Cirsium* spp. aff. *C. foliosum*) of western North America. Canad. J. Bot. 45:1733-1749.
- . 1969. Cytotaxonomy of some *Cirsium* species of the eastern United States, with a key to eastern species. Canad. J. Bot. 47:1257-1275.
- MORITA, N., M. SHIMIZU, and M. ARISAWA. 1973. Two new flavone glycosides from *Cirsium lineare*. Phytochemistry 12:421-424.
- OWNBEY, G. B. 1952. Nuttall's Great Plains species in *Cirsium*: *C. undulatum* and *C. canescens*. Rhodora 54:29-35.
- and Y. HSI. 1963. Chromosome numbers in some North American species of the genus *Cirsium*. Rhodora 65:339-354.
- . 1969. Chromosome numbers in some North American species of the genus *Cirsium*, II. Western United States. Madroño 20:225-228.
- PETRAK, F. 1917. Die nordamerikanischen Arten der Gattung *Cirsium*. Beih. Bot. Centralbl. 35(2):223-567.
- RYDBERG, P. A. 1906. Flora of Colorado. Agric. Exp. Sta. Agric. Coll. Colorado, Bull. 100. (*Carduus*, pp. 398-402)
- . 1917. Flora of the Rocky Mountains and adjacent plains. Published by the author, New York. (*Cirsium*, pp. 1003-1014, 1068-1069)
- SNOW, R. 1963. Alcoholic hydrochloric acid-carmines as a stain for chromosomes in squash preparations. Stain Technol. 38:9-13.
- TURNER, B. L. and R. E. ALSTON. 1959. Segregation and recombination of chemical constituents in a hybrid swarm of *Baptisia laevicaulis* × *B. viridis* and their taxonomic implications. Amer. J. Bot. 46:678-686.
- WALLACE, J. W. and B. A. BOHM. 1971. Cirsimaritin-4'-O-rutinoside, a new flavone glycoside from *Cirsium brevistylum*. Phytochemistry 10:452-454.